CLAIMS

What is claimed is:

1. A method of producing a signal, comprising:

providing a first signal having a first frequency;

providing a second signal, the second signal having a frequency that is adjustable by a first step size;

providing a third signal, the third signal having a frequency that is adjustable by a second step size;

producing a fourth signal; and

mixing the third signal with the fourth signal to produce a fifth signal;

wherein producing the fourth signal comprises mixing the first signal with the second signal.

2. The method of Claim 1, wherein the units of the first and second step sizes are Hz, the frequency of the second signal is the first step size times N, where N is an integer, the frequency of the third signal is the second step size times M where M is an integer, and i times M is equal to N ± 1, where i is an integer.

3. The method of Claim 2, wherein providing the second signal comprises operating a first local oscillator.

4. The method of Claim 2, wherein providing the third signal comprises operating a second local oscillator.

5. The method of Claim 2, wherein providing the second signal comprises operating a first local oscillator, providing the third signal comprises operating a second local oscillator, and each of the first and second local oscillators includes a phase-locked loop.

6. The method of Claim 5, further comprising bandpass filtering an output signal produced by the mixing of the first signal and the second signal.

7. The method of Claim 6, wherein the band pass filtering selects an upper sideband of the output signal produced by the mixing of the first signal and the second signal.

8. The method of Claim 6, wherein band pass filtering selects a lower sideband of the output signal produced by the mixing of the first signal and the second signal.

9. The method of Claim 7, further comprising selecting an upper sideband of the fifth signal.

10. The method of Claim 8, further comprising selecting a lower sideband of the fifth signal.

11. The method of Claim 6, wherein providing the first signal comprises receiving the first signal.

12. The method of Claim 6, wherein providing the first signal comprises generating the first signal.

13. The method of Claim 6, further comprising providing at least one predetermined pair of values for N and M.

14. A method of downconverting a signal, comprising:

providing a first, second, third, fourth and fifth signal, wherein the second signal has a frequency L2, the third signal has the frequency L2 and is phase shifted 90° with respect the second signal; the fourth signal has a frequency L1, and the fifth signal has the frequency L1 and is phase shifted 90° from the fourth signal;

splitting the first signal to produce a first splitter output signal and a second splitter output signal;

mixing the first splitter output signal with the second signal to produce a first mixer output signal, and low pass filtering the first mixer output signal to produce a first filter output signal;

mixing the second splitter output signal with the third signal and low pass filtering to produce a second mixer output signal, low pass filtering the second mixer output signal to produce a second filter output signal;

mixing the first filter output signal with the fourth signal to produce a third mixer output signal;

mixing the second filter output signal with the fifth signal to produce a fourth mixer output signal; and

combining the third mixer output signal and the fourth mixer output signal to produce a combiner output signal;

wherein frequency L2 is adjustable by a first step size, frequency L1 is adjustable by a second step size, frequency L2 is the first step size times N, frequency L1 is the second step size times M, and i times M is equal to N ± 1, where i, M and N are integers.

15. The method of Claim 14, wherein providing the second, third, fourth and fifth signals comprises operating at least two local oscillators, each local oscillator including a phase-locked loop.

16. The method of Claim 15, further comprising changing the output frequency of at least one of the least two local oscillators.

17. A method of upconverting a signal, comprising:

providing a first, second, third, fourth and fifth signal, wherein the second signal has a frequency L2, the third signal has the frequency L2 and is phase shifted

90° with respect the second signal; the fourth signal has a frequency L1, and the fifth signal has the frequency L1 and is phase shifted 90° from the fourth signal;

splitting the first signal to produce a first splitter output signal and a second splitter output signal;

mixing the first splitter output signal with the second signal to produce a first mixer output signal, and high pass filtering the first mixer output signal to produce a first filter output signal;

mixing the second splitter output signal with the third signal and high pass filtering to produce a second mixer output signal, low pass filtering the second mixer output signal to produce a second filter output signal;

mixing the first filter output signal with the fourth signal to produce a third mixer output signal;

mixing the second filter output signal with the fifth signal to produce a fourth mixer output signal; and

combining the third mixer output signal and the fourth mixer output signal to produce a combiner output signal;

wherein frequency L2 is adjustable by a first step size, frequency L1 is adjustable by a second step size, frequency L2 is the first step size times N, frequency L1 is the second step size times M, and i times M is equal to N ± 1, where i, M and N are integers.

18. The method of Claim 17, wherein providing the second, third, fourth and fifth signals comprises operating at least two local oscillators, each local oscillator including a phase-locked loop.

19. The method of Claim 17, further comprising changing the output frequency of at least one of the least two local oscillators.

20. The method of Claim 21, further comprising changing the frequency L2 by an integer multiple of the first step size, and changing the frequency L1 by an integer multiple of the second step size.

21. A circuit, comprising:

a first local oscillator having a first step size, the first local oscillator having an output terminal;

a first mixer having a first input terminal adapted to receive a first signal, a second input terminal coupled to the output terminal of the first local oscillator, and further having an output terminal;

a second local oscillator having a second step size, the second local oscillator having an output terminal; and

a second mixer having a first input terminal coupled to the output terminal of the first mixer, a second input terminal coupled to the output terminal of the second local oscillator, and further having an output terminal;

wherein first and second local oscillators each comprise a phase-locked loop, and the first step size is NX, the second step size is MX, X has units of Hz, and i times M equals N±1, where i, M and N are integers.

22. The circuit of Claim 21, further comprising a filter coupled to the output of the first mixer.

23. The circuit of Claim 22, wherein the filter is a high pass filter.

24. The circuit of Claim 23, wherein the filter is a low pass filter.

25. The circuit of Claim 21, wherein the first and second local oscillators each include at least one input terminal adapted to receive information regarding a desired output frequency of that local oscillator.

26. The circuit of Claim 22, further comprising a first signal source coupled to the first input terminal of the first mixer.

27. The circuit of Claim 22, further comprising a third mixer coupled to a fourth mixer, the third mixer coupled to a quadrature output terminal of the first local oscillator and the fourth mixer coupled to a quadrature output terminal of the second local oscillator.

28. A converter for radio applications, suitable for integration on a single chip, comprising:

a first and a second frequency synthesizer, each comprising a phase-locked loop, and each adapted to provide an in-phase output signal at an in-phase output signal terminal, and a quadrature output signal at a quadrature output signal terminal;

a first and a second mixer coupled, respectively, to the in-phase and quadrature output signal terminals of the first local oscillator;

a third and a fourth mixer coupled, respectively, to the in-phase and quadrature output signal terminals of the second local oscillator;

a power splitter having a first output terminal coupled to the first mixer, and a second output terminal coupled to the second mixer;

a combiner having a first input terminal coupled to an output terminal of the third mixer, and a second input terminal coupled to an output terminal of the fourth mixer;

a first filter coupled to an output terminal of the first mixer and further coupled to an input terminal of the third mixer;

a second filter coupled to an output terminal of the second mixer and further coupled to an input terminal of the fourth mixer; and

a signal source coupled to an input terminal of the power splitter;

wherein the first frequency synthesizer has a first step size NX, the second frequency synthesizer has a second step size MX, and $iM = N \pm 1$, where N, M and i are integers.

29. The converter of Claim 28, wherein the first and second filters are low-pass filters and the converter is a downconverter.

30. The converter of Claim 28, wherein the first and second filters are high-pass filters and the converter is an upconverter.

31. The converter of Claim 28, wherein the first and second filters are bandpass.

32. An image reject mixer, comprising:

a first and a second local oscillator, each comprising a phase-locked loop, and each adapted to provide an in-phase output signal at an in-phase output signal terminal, and a quadrature output signal at a quadrature output signal terminal;

a first and a second mixer coupled, respectively, to the in-phase and quadrature output signal terminals of the first local oscillator;

a third and a fourth mixer coupled, respectively, to the in-phase and quadrature output signal terminals of the second local oscillator;

a first power splitter having a first output terminal coupled to the first mixer, and a second output terminal coupled to the second mixer;

a combiner having a first input terminal coupled to an output terminal of the third mixer, and a second input terminal coupled to an output terminal of the fourth mixer;

a first filter coupled to an output terminal of the first mixer and further coupled to an input terminal of the third mixer;

a second filter coupled to an output terminal of the second mixer and further coupled to an input terminal of the fourth mixer;

wherein the first local oscillator has a first step size NX, the second local oscillator has a second step size MX, and $iM = N \pm 1$, where N, M and i are integers.

33. The circuit of Claim 32, wherein the first and second filters are bandpass filters.

34. The circuit of Claim 33, wherein the bandpass filters are low-pass filters.

35. The circuit of Claim 33, wherein the bandpass filters are high-pass filters.

36. The circuit of Claim 33, further comprising a signal source coupled to an input terminal of the power splitter.